

Evaluation and use of the standards in of the technical drawings in the final year project

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Abstract

In the Industrial Engineering and Chemical Engineering courses of Madrid Polytechnic University the core subjects of Technical Design are taught on the first course but under different names in the first and second four month periods of this degree. The Final Year Project (FYP) is usually the first work in which engineers do a complete engineering project that includes different parts, such as a memory, measuring, budgets and technical drawings.

This work sets out to learn and assess the use students make of the knowledge acquired in Technical Drawing subjects when preparing their FYP technical drawings. By analyzing different aspects of 1996 technical drawings included in the FYP about different scopes, it is hoped to be able to see how this specific knowledge is applied to the different specialties (mechanical, electrical, chemistry, etc.) of the degree, as well as the project topics, the type of information contained, the correct use of standards, the tools used to prepare them, etc. The paper has been conducted taking the FYPs of the last 4 years as reference for all the specializations.

The purpose of this work was to detect any deficiencies, errors in knowledge, malpractice in execution, etc, in order to have additional information that will enable course content, assessment, and the teaching methodology of the subjects to be adjusted in order to improve teaching. The results of this work are implemented in the contents and practices of the subjects of the technical drawing and a new subject was also proposed.

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1. Introduction

The ETS of Industrial Engineers of Madrid Polytechnic University teaches the core subjects of Technical Drawing under different names in the first course of the Industrial Engineering degree. These studies are then embodied in nine specialties depending on the area of specialization chosen by the student in advanced courses. Throughout their degree course students do indeed frequently make use of the competencies and skills acquired and practiced in the course. However, a major part of the specific knowledge associated with the topics in Technical Drawing is fairly flexibly applied throughout the length of studies as it is usually applied to drawings done by hand

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and not to technical drawings. This means that in the course of the degree it is not very usual for students to have to put into practice a large part of the specific knowledge taught, and when they have to do so, errors, even serious errors are usually tolerated to quite a large extent.

The main aim of the research undertaken is to find out if students retain some of the knowledge that they learned and demonstrated on some particular occasion, and also where such knowledge is applied in order to be able to stress the need to improve our teaching by discovering some of the possible shortcomings in learning that have occurred over time.

It is in technical drawings that this knowledge has to rigorously applied, which is usually the Final Year Project (FYP), the first genuine, comprehensive engineering project where students usually include drawings. Therefore, what we are aiming for is to find out and evaluate the use made of their knowledge of graphic expression and also discover any possible educational lacunae regarding the preparation of the technical drawings produced for the Projects in the final year of studies.

Various studies have been made on the importance of doing these kinds of final year projects, since they combine technical skills (problem-solving) and finding a correct solution (efficiency). They must also defend their FYP before a board of examiners (communicative skills) (Hans-Jorg et al., 2006) (Vitner et al., 2009) who will assess this work (Jawitt et al., 2002). They will judge if the communicative skills of writing, reading (Block et al., 2009) and oral language (Pappas et al., 2005) have been studied through quantitative and qualitative methods as well as judging the design engineering language possessed by students (Atman et al., 2008). At the very end students do not always put their knowledge of design into practice, which suggests there is a need for educational improvements and research to fill this gap (Martin-Dorta et al., 2007). Few studies have been carried out to assess engineering degree students' spatial abilities, which are practically non-existent in the final year project (FYP). Such studies usually refer to the initial courses or fast remedial courses (Onyancha et al., 2009), the improvements acquired by the use of CAD programs (Rafi et al., 2006) (Sorby et al., 2009) and the inherent differences between women and men on engineering courses (Friedman, 1995) (Marra et al., 2009) (Rafi et al., 2009) particularly in mathematics and spatial vision.

2. Typology and nature of Final Year Projects (FYP)

The typology and nature of the FYP on the Industrial Engineering Degree is as rich and varied as is the industrial sector towards which the student undertaking the project is headed. In spite of this, and without wishing to impose any restrictions, the three following models based on research undertaken by (Sánchez Naranjo et al, 2007) have been chosen to conduct this study by analyzing FYPs from 1989 to 2005, which have served as a basis for approaching our study.

Type 1: Classic engineering project: The main feature of this type of project is that its structure must adapt to what is demanded by official projects requiring the stamp of Professional Bodies, that is, a report, technical drawings, specifications and budget.

Type 2: Theoretical-experimental works: Works of a theoretical, computational and/or experimental nature comprising a contribution to technology in different fields of engineering which, when appropriate, includes financial assessment and the discussion and assessment of results. Many of the FYPs produced in the Departments of the Centre form part of this typology. They are usually R+D+I projects.

Type 3: Technical, organizational and economic studies: Carrying out studies linked to equipment, systems and services, etc, that are connected with the fields covered by the degree. They deal with any of the aspects of design, planning, production, management, operation and anything else pertaining to the field of engineering, and when appropriate, comparing different technical alternatives with financial assessments followed by a discussion and evaluation of the results.

These methods have been studied for the new specialties taught in this school and reflect a clear decrease in type 1 classic engineering project work in all specialties although in the specialties of civil engineering and machines this type remains a majority.

3. Results of the study

The study was made taking the type 1 FYPs as reference (classic project) presented between the 2005-06 and 2006-07 courses, and focuses on the analysis and assessment of the knowledge associated with Technical Drawing subjects attending to diverse criteria, such as:

- Specialties and number of type 1 projects
- Project topics
- Technical drawing topics
- Use of standards

These projects were studied because they are physically available, something that is not the case with other years. FYPs are periodically destroyed to ensure their confidentiality, particularly when they are linked to companies.

The different specialties of the industrial engineering degree have been examined as follows:

- Electronics
- Electrical
- Civil Engineering
- Machines
- Materials
- Industrial engineering
- Chemistry
- Energy Engineering

A grant-holder was taken on to input the assessment data for the projects undertaken by teachers in accordance with the chosen criteria. These questionnaires have enabled two data bases to be prepared. In order to facilitate data input and the simultaneous access from different points some ASP pages were designed. The general data for the sample taken for the study are shown in Table 1.

Table 1. General data of the sample	
No. projects	56
Years	2005-06 to 2006-07 courses
Specialities	All except materials and manufacturing
Total no. technical drawings	1996

Different analyses were performed. Some of them are listed below:

3.1. Specialties and number of type 1 projects

Figure 1 shows the distribution of the FYPs analysed and the technical drawings of each Project, according to speciality. It can be seen that the average for technical drawings by speciality fluctuates between 30 and 60 drawings, with the specialties of Chemistry and Energy Sciences being the most numerous. The specialties of Materials and Manufacturing are not included due to the fact that there were no projects with drawings among the documentation.

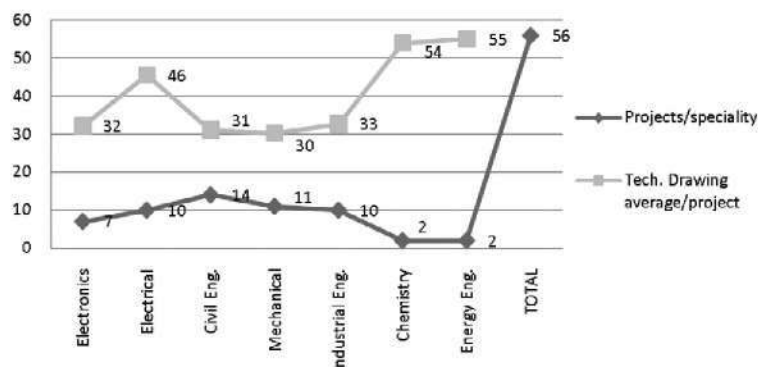


Figure 1. Projects studied by specialty and average number of Technical Drawings per project

Figure 2 shows the total number of technical drawings revised for each degree specialty. As previously stated in these calls there were no type 1 projects for the materials and manufacturing specialties.

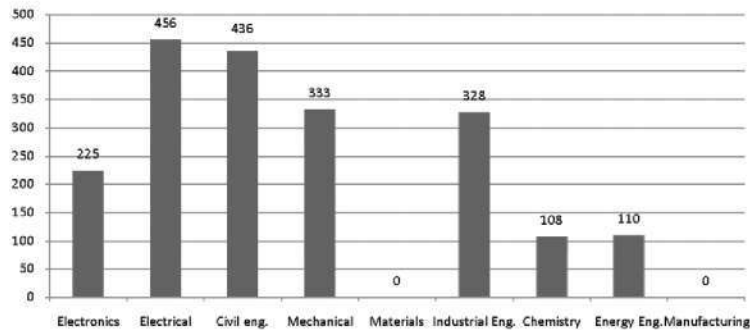


Figure 2. Number of Technical Drawings revised by specialty

It was considered that sufficient data could be obtained for the specialties for which technical drawings were available to reach valid conclusions for the aims of this study.

3.2. Subject matter of type 1 projects

This project only takes account of the Projects that included technical drawings among the documentation and the same Project may contain technical drawings of very varying content, for example, technical drawings of the structure of a building with the technical drawings for including a warehouse, or drawings of service facilities, a machine design or any specific component in the facility. Therefore, this study, includes but is not limited to, four project types that address the main problem to be solved, which do not exclusively depend on the specialty to which the study refers.

- Civil or industrial Infrastructures
- Service facilities for buildings or industries
- Whole industrial buildings
- Design

Figure 3 shows that projects associated with Facilities dominate (35), followed by industrial infrastructure (14) concentrating on the specialties of civil engineering, mechanical and industrial organisation. There were 6 machinery design projects, mainly on civil engineering and machines. Only 2 projects tackled a whole industrial complex.

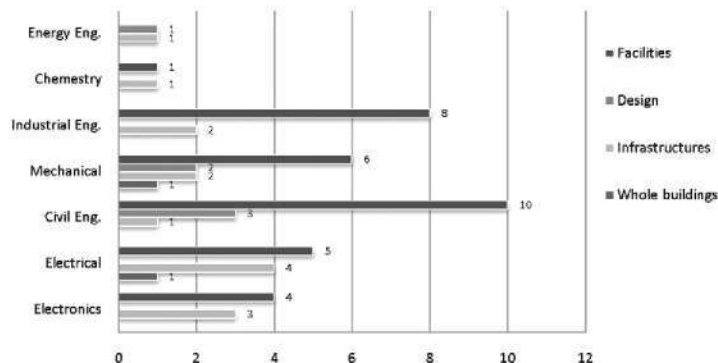


Figure 3. Projects analysed by topic and specialty (scope of the FYP / specialty)

3.3. Use of a set of standards

One of the basic features defining the representational systems forming the basis of technical drawing is the universality of the documents. This requires complying with a set of standards which are sometimes extremely

rigorous. Figure 4 shows the application of technical drawing standards concerning the identifying elements that every technical drawing must contain in its title block.

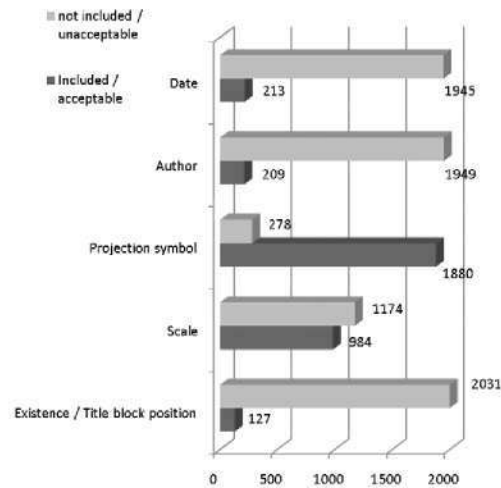


Figure 4. Title block use and its elements

Figure 5 shows the application of drawing standards concerning other elements of the drawing. The errors existing in the way the drawings are folded, the representation of standardised items such as screw threads and the use of lines of the right thickness and type. Dimensioning and the use of colour were generally correctly used. A small proportion of drawings showed errors mixed with correct representations and these are indicated with the “sometimes” label.

However, the overall application of standards is deficient for all of the specialities. There are errors of standardisation or a lack of application of technical drawing standards in 72% of the drawings revised on average.

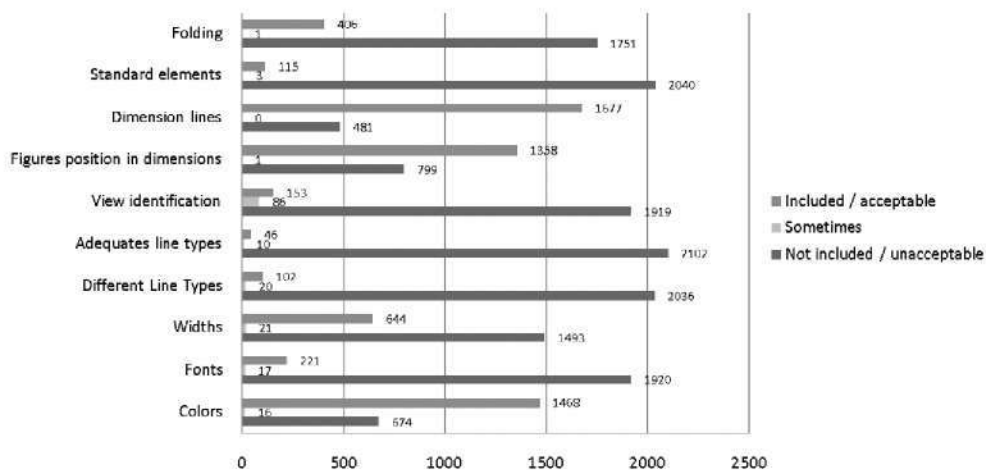


Figure 5. Application of standards; layouts (all specialties)

4. Conclusions

The inclusion of subjects in the curriculum should set criteria that allow assessing the teaching processes and the degree to which the aims are achieved and lead to feedback regarding the aims and methods and the proposal of alternatives for updating course content together with teaching plans for renewing methods. In the light of all this, preparing studies such as this one is vitally important.

The project sample taken was considered sufficient, and the statistical analysis performed leads to the following basic conclusions:

- In practically every specialty, technical drawings were included among the project documentation, even though it was more frequent in civil engineering, machines, organizational and electrical engineering.
- The most usual information included was of two types: implementation, layouts, instrumentation and control, diagrams, schemes, and facilities, with a 2D drawing being the most frequently used.
- There is no noticeable difference between specialties.
- Specific engineering graphics know-how was not properly used.
- A considerable amount of specific knowledge demonstrated by students on a particular occasion and deemed fundamental to graphic expression were not put into professional practice.
- A greater involvement of FYP directors to try to prevent these errors.
- The inclusion of engineering graphics subjects in higher courses and not only as part of basic training.

In the light of the results, we have proposed the inclusion of a free-choice subject called “Project-oriented Technical Drawing”, with course content that is clearly aimed at producing quality Technical Drawings for Projects. This subject has already been introduced in the present 2009-2010 course and it must be said that all the available places have been covered (50).

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